Lest this talk of reenchanting science be associated with a “haze of romantic nostalgia,”¹ either in the sense of a lack of clarity or a kind of preciousness, the concept of wonder must be made more concrete. This chapter endeavors to do just that, exploring, first of all, why it makes sense to talk about wonder in the context of the popular science of the 1980s. One cannot fully understand *Biophilia*, *Gaia*, or *Cosmos* without looking at the narratives of disenchantment, beginning, arguably, with Weber, and reaching a fever pitch in the 1970s and the 1980s with calls for a less alienated science. Against this backdrop, a reenchanted and reenchanting popular science can be understood as a way of negotiating what comes “after” disenchantment, refusing both a return to the naïve animisms of the past, as well as a no-holds-barred glorification of technoscience.

As I explain in the second section of this chapter, these works align themselves much more comfortably with the quasi-vitalist frameworks found in contemporary vital and incorporeal materialisms, as well as Karen Barad’s agential realism. The frame-

¹ Rita Felski, *Uses of Literature* (Oxford: Blackwell Publishing, 2008), 76. Felski here is referring to the enchantment occasioned by a text — a style of reading made suspect by, for instance, Frankfurt School thinkers, but the suspicion towards it can be thought of more broadly as well.
works are united by their rejection of mechanist views, understanding reality as a perpetual unfolding of potentials and as teeming with organic and inorganic life arising from and embedded in the interaction of matter. Affect, as the “felt reality of relation,” is also central to these accounts, and the more detailed exploration of it within these frameworks gives us a vocabulary with which we might begin to define affective wonder and distance ourselves from the sentimental.

This, indeed, is the task taken up by the third section of this chapter, which argues that wonder can be usefully conceptualized in an ecological sense as the attunement to new affects, or with Jacob von Uexküll, as the expansion of the Umwelt via the experience of new affects. As Uexküll elaborates on the nature of the Umwelt,² he returns again and again to the figure of the scientist, and it is in his discussions of the inquiring subject, in particular, that one gets a sense of wonder’s potential to take the human beyond itself.

The final section of this chapter turns at last toward the works themselves and identifies how a reenchanted science operates in practice. Here, I outline what guided the readings of the works in the following chapters. Although the analytic portions of the readings focus on wonder’s many manifestations within the texts, what gives texture and, ultimately, meaning to them are the connections to be drawn between affective wonder, the enchanted science they present, and ecological praxis. To this end, I will propose a framework for the series of very non-hermetic close readings that I embark on in the following chapters.

2.1

Disenchantment and Its Discontents

Rather than conceiving of the popular scientific works of the 1980s in a vacuum, one ought to keep in mind that their engagement with affective wonder might be seen as a larger project to, in Morris Berman’s words, “reenchant the world,” to undo the disenchantment Max Weber argued was accomplished by modernity. This project may be seen as much as an effort that followed naturally from sciences that no longer perceived the same disconnect between the observer and the observed as an attempt to overcome a conception of science as only serving the most narrowly anthropocentric interests.

This section begins by outlining the story of disenchantment, first as articulated by Max Weber, and then as taken up by others like Morris Berman, explaining, along the way, how we might understand a disenchanted science. But, as Jane Bennett reminds us, “The modern story of disenchantment leaves out important things.” The disenchantment story may be seen as just that — a story — and here we examine how it might easily be described as a fantasy or, at best or perhaps worst, self-fulfilling prophecy. This section asks, in other words, that the self-evidence of disenchantment be done away with, and that we turn, ultimately, to those enchantments “already in and around us.”

2.1.1. Disenchantment demystified

The story of disenchantment cannot be disentangled from the scientific and industrial revolutions. Max Weber argued, famously, that these had triggered the “intellectual process of rationalization through science and a science-based technology.”

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5 Ibid., 159–60.
6 Max Weber, “Science as a Vocation,” in The Vocation Lectures, trans. Rodney Livingstone, eds. David Owen and Tracy B. Strong (Indianapolis:
This, for him, did not mean that individuals could necessarily explain the working of the world any better, only that the forces behind lived reality were, in theory, no longer mysterious (and therefore no longer enchanting), because an explanation could be sought out. It is not as if, in other words, the advancement of science and technology implied with it “a growing understanding of the condition under which we live.” Weber argued that we hardly possess “a greater knowledge of the conditions determining our lives than an Indian, or a Hottentot,” and that, “[u]nless we happen to be physicists, those of us who travel by streetcar have not the faintest idea of how the streetcar works.”

Indeed, the notion that, at least potentially, all explanations of our physical surroundings are available to us, even if we do not know them offhand, could only have become more entrenched in the Internet age.

Where the full force of disenchantment is felt here, however, is in the emergence of an anthropocentric cosmos in which we attribute more agency and power to the human than we ever have before. Weber continues:

[I]n principle, then, we are not ruled by mysterious, unpredictable forces, but […], on the contrary, we can in principle control everything by means of calculation. That in turn means the disenchantment of the world. Unlike the savage for whom such forces existed we need no longer have recourse to magic in order to control the spirits or pray to them. Instead, technology and calculation achieve our ends.

If this sounds familiar, and it should, it is because so many since Weber have repeated some version of this: We have become as gods. Weber himself was deeply ambiguous about this “ration-
alization and intellectualization,” stating, “Its resulting fate is that precisely the ultimate and most sublime values have withdrawn from public life. They have retreated into the abstract realm of mystical life or into the fraternal feelings of personal relations between individuals.”11 If disenchantment is the emptying of mystery (and therefore meaning) from the world, it is also the destruction here of a sacred commons. For Weber, as well, modern religion offers “[r]elease from the rationalism and intellectualism of science.”12 Enchantment, in his world, has retreated fully to enclaves in the private sphere.

The historian Lynn White takes up a number of these themes up in the late 1960s, in an article appearing in Science entitled “The Historical Roots of Our Ecological Crisis.”13 For White, notably, it is not merely the “rationalization and intellectualization of science” that has brought about an all-pervasive disenchantment; he describes a fatal cocktail involving the rise of Christianity, which for Weber still constituted something of a refuge, and the wedding of technology to science accomplished by democracy. White explains, “Science was traditionally aristocratic, speculative, intellectual in intent; technology was lower-class, empirical, action-oriented.” The democratic revolutions of the mid-nineteenth century and the dissolution of many social barriers that went along with them, White claims, created a “functional unity of brain and hand.” Very much ahead of his time, White then states: “Our ecologic crisis is the produce of an emerging, entirely novel, democratic culture.”14

In this narrative, the investment of science with telos, via the fusion with “low” technology, destroys its speculative character, which one might assume allowed it, at one time in history, to

Fred Turner, From Counterculture to Cyberculture (Chicago: University of Chicago Press, 2006), 82.
12 Ibid., 16.
14 Ibid., 1204.
possess some degree of enchantment. White recognizes that, while this “unity of brain and hand” was part and parcel of democratic culture, it had devastating consequences in terms of the damage that could now be inflicted upon the earth; technoscience not only pretended, and arguably still pretends, to comprehend the world, but also to make it bend to its will. One need only think back to the nuclear science occupying so many scientists during World War II and the Cold War era in order to imagine just how much the unity of brain and hand had both accomplished and devastated, or could at least in theory devastate. It is no accident that the scientists examined in this work attempt to turn back to this more speculative science (and were, in fact, heavily criticized by those within the academy for this). They had all at least experienced the nuclear era, and Sagan and Lovelock have spoken and written at length about both nuclear weapons and power. Although at no point in time do these scientists argue for the divorcing of science from technology, what they offer is an ethically guided science for its own sake.

In subsequent articulations, in the 1980s, this vision of disenchantment becomes less nuanced and more focused on the consequences for the individual. It is the emergence of scientific consciousness, as Berman phrases it, at the beginning of modernity that allows participants in the cosmos to imagine themselves as somehow separate from it:

Scientific consciousness is alienated consciousness: there is no ecstatic merger with nature, but rather total separation from it. Subject and object are always seen in opposition to each other. I am not my experiences and thus not really a part of the world around me. The logical end point of this world view is a feeling of total reification: everything is an object,

alien, not-me; and I am ultimately an object too, an alienated “thing” in a world of other, equally meaningless things.16

Scientific consciousness and the attendant disenchantment thus entails a double alienation — from the world, and the ability to conceive of oneself as part of it, and from subjectivity itself. Always accompanying this disenchantment of experience, moreover, is a “disenchantment of nature,”17 as David Ray Griffin terms it. He describes this as, “the denial to nature of all subjectivity, all experience, all feeling. Because of this denial nature is disqualified — it is denied all qualities that are not thinkable apart from experience.”18 And “apart from experience” here already means apart from the disenchanted experience of the scientist, the limitation, in Uexküll’s terms (which we will discuss later in this chapter), to one tiny sector of nature. There is no room for the Deleuzian virtual in a disenchanted science, for that net of relations that itself comprises the subject; the scientist, impossibly, stands apart.

This begs the question: what was it like before? How do these authors describe an enchanted world? White, for one, makes reference to the genius loci, the guardian spirit of antiquity, claiming, “These spirits were accessible to men, but were very unlike men […]. Before one cut a tree, mined a mountain, or damned a brook, it was important to placate the spirit in charge of that particular situation, and to keep it placated.” He goes on to say that, “By destroying pagan animism, Christianity made it possible to exploit nature in a mood of indifference to the feeling of natural objects.”19 The world, prior to the ascent of modern science and religion, is suffused with spirit — in a word, animist.

Berman paints a similar picture of a cosmic garden of Eden, writing, “The view of nature which predominated in the West

16 Berman, Reenchantment of the World, 17.
18 Ibid., 2.
19 White, “Historical Roots,” 11.
down to the eve of the Scientific Revolution was that of an en-
chanted world. Rocks, trees, rivers, and clouds were all seen
as wondrous, alive, and human beings felt at home in this
environment.”20 Before the advent of scientific distance, “A
member of this cosmos was not an alien observer of it but a
direct participant in its drama.”21 The world before the scientific
revolution is framed as a kind of pleasure garden. That some
members of this cosmos may not have found it so benign is, of
course, never presented as a possibility. The point is that, prior
to the development of scientific consciousness, there could be
no clash, and certainly no distance, between human and envi-
ronment. Humans had not yet learned to be directors but were
still actors in a drama. And not only was there no separation
between subject and object, but no part of this world could be
described as object, or inert, at all. This leads many theorists,
unsurprisingly, to trace the contemporary disregard for the
earth and environmental crisis itself to the disenchantment of
the world accomplished by science.

Jane Bennett gives her own, lengthier overview of disen-
chantment narratives in The Enchantment of Modern Life, to-
gether with a rather wryly administered disenchantment quiz
intended to gauge one’s own degree of disenchantment. After-
ward, she summarizes the features of the concept:

(1) our modern, highly rationalized world, characterized by
calculation, stands in stark contrast to a magical or holistic
cosmos, a cosmos toward which we have a double orienta-
tion of superiority and nostalgia; (2) although this world
opens up a domain of freedom and mastery, we pay a psychic
or emotional toll for demagification in the form of a lack of
community and a deficit of meaning; (3) the idea of progress
through science inspires both hope and despair; (4) even in
societies in which rationalization has advanced the furthest,
recalcitrant fugitives from rationalization persist, and these

20 Berman, Reenchantment of the World, 12.
21 Ibid.
errant forces are understood through the categories of the mystical and the erotic.  

Here, Bennett articulates the ambiguity surrounding disenchantment well. Disenchantment involves the supposed victory of reason over the mysterious forces of the world, and this is attached both to a triumphalism over these forces and despair at what has been lost. No longer viewing ourselves as part of the cosmos, we invest these former energies in a kind of ceaseless scientific march forward, but cannot adequately answer the question, “What for?” Finally, Bennett, crucially, points out that even the theorists of disenchantment themselves acknowledge leaks; these are the “recalcitrant fugitives of rationalization,” and are especially important for this project. In the writings of Wilson, Lovelock, and Sagan, it is argued here, science attempts to outrun its own shadow, to return to the possible, the speculative, as opposed to that which can be verified and rationalized.

2.1.2. The disenchantment fantasy

The question is, of course, how much credence one ought to grant the grand narrative set out by those describing disenchantment. My contention is that, even though the narrative itself is essential to understanding the climate in which the popular science of the 1980s operated, one ought to regard it with suspicion.

The first and primary reason to do this is that the very embeddedness of the narrative itself has now become inseparable from any disenchanting effect that modern science or its fusion with technology may have had or continue to have. In short, in its pervasiveness, disenchantment has become, at least in part, a self-fulfilling prophecy. Bennett puts it especially succinctly when she writes, “For me the question is not whether disenchantment is a regrettable or a progressive historical development. It is, rather, whether the very characterization of the world as disenchanted ignores and then discourages affec-

tive attachment to that world.”23 The disenchantment narrative, in a strange twist, itself disenchants, and it becomes irrelevant whether the disenchantment precedes the narrative or not. What is especially important in Bennett’s critique of disenchantment, moreover, is her mention of affective attachment. The very notion that there is a separation between the human and the world limits, in many ways, the kinds of relationships that can transpire between them. Bennett thus argues that “the enchantment effect,” this intense affective attachment to the world, rests on the ability “to resist the story of the disenchantment of modernity.”24 She asks, again and again, and in a way that echoes the wonder-inducing strategies in popular science to be discussed later, “But what if the contemporary world is not disenchanted?”25 If disenchantment is a self-fulfilling prophecy, the first step to “recovering” enchantment, regardless of how or even if we have lost it, is asking this question.

The disenchantment narrative, furthermore, is described by both Bennett and Latour as a self-indulgent fantasy. What, they ask, makes us so special as to be the only ones who have conceived of themselves as being ripped from the cosmos or abandoned in an empty universe? Bennett observes, “After all, a sense of insecurity and the spectre of meaninglessness are not specific to modernity; experiences of undeserved suffering and inexplicable evil have regularly called into question the safety and viability of the universe for humans.”26 We have no way of knowing that the lives of those that lived before us were suffused with meaning, and we have many methods that allow us to point to how cruel they may have been. Latour is even more severe in his assessment of the forces driving the disenchantment tale, musing that Westerners “like to frighten themselves with their own destiny.”27 “Why,” he asks, “do we get so much pleasure out

23 Ibid., 3.
24 Ibid., 3–4.
25 Ibid., 34.
26 Ibid., 66.
of being so different not only from others but from our own past? What psychologist will be subtle enough to explain the morose delight in being in perpetual crisis and in putting an end to history?” 28 Here, disenchantment is a kind of masochism, a kind of “poor me” that multiplies with every development we decide is modern. Latour adds disenchantment, in fact, to a list of modern woes we simultaneously decry and relish, exclaiming,

Haven’t we shed enough tears over the disenchantment of the world? Haven’t we frightened ourselves enough with the poor European who is thrust into a cold soulless cosmos, wandering on an inert planet in a world devoid of meaning? Haven’t we shivered enough before the spectacle of the mechanized proletarian who is subject to the absolute domination of a mechanized capitalism and a Kafkaesque bureaucracy, abandoned smack in the middle of language games, lost in cement and formica? Haven’t we felt sorry enough for the consumer who leaves the driver’s seat of his car only to move to the sofa in the TV room where he is manipulated by the powers of the media and the postindustrialized society?! 29

It is not as if Latour dismisses these woes entirely, but he questions here whether endlessly bewailing the state of the world does more to reinforce these woes than to provide the kind of critique necessary for imagining other modes of living. The catastrophism spoken of in this volume’s introduction might be taken as another instance of this; while its roots are material, we often conceive of it as a straightforward description of what is and a lament for what has been lost.

As an alternative to perversely pretending to dwell in a disenchanted world, Latour suggests, like Bennett, that we direct ourselves to the enchantments “in and around us.” To do this, he points to the wonders both science and industry themselves

28 Ibid., 114.
29 Ibid., 115.
produce, asking, “How could we be capable of disenchancing the world, when every day our laboratories and our factories populate the world with hundreds of hybrids stranger than those of the day before?” 30 In attending to the nonhuman biological, earth systems, and outer space, the authors discussed here take a slightly different track from Latour’s; what drives enchantment for them are not the strange man-made hybrids Latour alludes to, but the experience of forms and processes that can never be entirely rationalized.

2.1.3. What becomes of the disenchanted
It is not as if debunking or casting doubt on disenchantment, however, magically resurrects the “holistic, or participating, consciousness” 31 theoretically possible before the scientific revolution. Resisting the great disenchantment narrative also means resisting the idea of the cosmological garden of Eden in which a fully holistic, participating consciousness may have dwelled. It is, perhaps, better to accept that disenchantment lives side by side with enchantment in the lives of most and that the great disenchantment narrative is now simply in need of counterbalancing. If, after all, the disenchantment narrative is powerful enough to constitute a self-fulfilling prophecy, as Bennett suggests, counter-narratives have the potential to alter the manner in which we engage with and conceptualize reality.

The disenchantment theorists writing in the 1980s had interesting ideas for how one might overcome large-scale disenchantment, and even if one does not buy into the idea of disenchantment as a fall from an ecological and spiritual state of grace, they are worthy of attention. Berman suggests, for instance, that Gregory Bateson’s work and cybernetic thought provide a possible avenue for bridging the canyon between subject and object created by this disenchantment. Others suggest that we learn to tell new, scientifically informed creation stories,

30 Ibid.
31 Berman, Reenchantment of the World, 32.
partaking in what Brian Swimme calls “cosmic storytelling.” In these accounts, science itself possesses the ability to reenchant and usher in a community of “Earthlings.” What many seem to agree on is Stephen Toulmin’s assertion that, within a postmodern science, “the pure scientist’s traditional posture as theoros, or spectator, can no longer be maintained.”

More recently, sociologist William Gibson has spoken of a number of counter-disenchantment currents he refers to as “the culture of enchantment.” For him, this new culture revolves around the “reinvestment of nature with spirit” through environmental movements that seek to re-sacralize nature. The way in which they do this is not unproblematic, however, and he mentions the strategy of “tying a piece of land to a large, charismatic animal species — particularly animals nearing extinction” as a not terribly successful case in point, as the attempt to “restore the connection” can lead to laughably shallow or specific relations to environments and environmental issues that are actually very complex.

Gibson also calls attention to efforts to replace religious cosmologies with “evolutionary epics,” and cites E.O. Wilson himself as claiming that they are “as intrinsically ennobling as any religious epic.” The story of evolution, which many have argued is the story that science has to tell, is potentially a powerful counter-narrative, perhaps especially because it operates in biological and not human time. The scientific and industrial revolutions, at least in most accounts, do not constitute an evolutionary leap in and of themselves. In this sense, the biological,

33 Ibid., 47.
36 Ibid., 11.
37 Ibid., 73.
38 Ibid., 235.
religious epic can take us away from the anthropocentric narratives that are so essential to, for instance, a Weberian understanding of disenchantment.

But in this project I want to question whether science does not also and especially have something of a non-narrative nature (and culture) to contribute to reenchantment, or at least resisting the crippling disenchantment narratives. What I will present in the following chapters contains very little of the cosmological epic, but does, again and again, conjure up a world that is very much alive and brimming with potential. Unlike with the evolutionary or religious epic, however, these fabulous worlds, as Bennett terms them, are not purposive.\(^{39}\) Although they often marvel at the miracle of intelligent life, for instance, it is a statistical miracle, and generally not cast as the work of a divine power or the inevitable result of billions of years of evolution. The authors I discuss may allude to the evolutionary epic, but the real power of the texts to enchant comes when they set this aside for a moment and focus on the immediacy of experience and the contingency of life. The enchantments are fragmentary, coming and going, much as in everyday life. Their lack of purposiveness and narrative cohesion does not make them any less engrossing, and, on the contrary, if this fragmentariness more closely resembles something like day-to-day experience, there are good reasons to claim that it “out-enchants” more narratively oriented texts. The type of enchantment these texts conjure up is that of “a window onto the virtual secreted within the actual.”\(^{40}\)

It is not as if the enchantments we will confront in the following chapters refer us to an unseen transcendent realm. Instead, they look at the miraculous, contingent unfolding of the life processes that surround us. We will return to the notion of enchantment or wonder as a glimpse of the virtual later in this chapter.

For now, it is important to remember a number of things about the disenchantment story. The first is that it is deeply embedded in our understanding of modernity and the scientific

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40 Ibid., 131.
and industrial revolutions. As such, we can hardly think about the role of a supposedly enchanting science without seeing it as a response to this all-pervasive narrative of disenchantment. Secondly, the disenchantment story is just that—a story—and it is one we should take with a grain of salt. There are not only good reasons to doubt a cosmological garden of Eden succeeded by a rapid and violent spiritual fall, but given the pervasiveness of the narrative itself, it is likely that, as Bennett claims, it discourages the kind of investment in the world that might resemble enchantment in the first place; it is, in short, a self-fulfilling prophecy. The reason I have gone to such lengths to outline the disenchantment tale is not that I grant it any legitimacy, but rather because it is so pervasive. It is impossible to think through the texts in the following chapters without having any idea of why they pursue the strategies that they do. Popular science, I will argue, helps us to negotiate what comes after disenchantment, or at least the debunking of the disenchantment tale. Neither looking back with nostalgia on the animisms of the past nor viewing technoscience as the be-all, end-all of humanity, they insist on a third way, on affective investments in the world that are enriched and deepened by scientific worldviews.

2.2 One Way Out: Vital Materialism(s)

This third way could go by many different names, but in this work, I link it explicitly to Jane Bennett’s “vital materialism,” Brian Massumi’s “incorporeal materialism,” and Karen Barad’s agential realism. What they hold in common is a commitment to apprehending the world as a continuous unfolding of poten-

41 It should be noted that these texts also acknowledge much older “natural philosophical” precedents; see, for instance, Jane Bennett’s discussion of Lucretius in The Enchantment of Modern Life (81–84). For reasons of economy, this book limits itself to more contemporary works.
tials, populated by entities that are simultaneously stubbornly indiscrete and in possession of agentic capacities. Everything in these worlds, organic and inorganic, pulses with something vital, with the capacity to become otherwise. Rather than locating this vitality in any substance or higher power, however, Bennett, Massumi, and Barad insist that the potential for transformation lies in the interaction (or, according to Barad, intra-action) of matter.

To jump back briefly to what was covered in the introduction: Affect is central here because it is, by definition, what interrelation feels like—that “experienced in a lived duration that involves the difference between two states.” To this end, the virtual—the potential that permeates reality as it unfurls—is as significant as the measurable and material: the actual. Enchantment and wonder, as we will discuss in the next section, rely precisely on this potential that is no less real for being unlocatable, and we might recall here Massumi’s description of the paradox of a phenomenon being “[r]eal, material, but incorporeal.” Attending fully to affect means admitting that sensation, though of the body, is not reducible to the strictly physiological.

This section fleshes out the understanding of affect and the quasi-vitalist frameworks in which one might situate affect, beginning with one of the thornier questions raised by incorporeal materialism: How can we discuss the immediacy of affect, unfolding in the present, when attempts to make sense of it necessarily impose a certain distance? It also looks at the related question of the distinction between affect and emotion and explains why this work concerns itself primarily with the

44 Ibid., 5.
former. The second part of this section, “Immanent subjectivity” examines the way in which a vital materialism or incorporeal materialism problematizes more discrete notions of subjectivity, and elaborates how we might understand the inter- and intra-connected ecological subject. The last subsection, “Scientific entanglements,” brings this understanding to bear on the figure of the scientist, who, according to Barad, is but another entangled actor among many. The scientist is not only a key figure in this project, which, after all, revolves around the writing of three scientists, but also one essential to understanding these strange materialisms, in which the subject is always already caught up in that which he or she has deemed object.

2.2.1. Mediated immediacy
We may as well confront the fact that we can never speak of affect in any pure, unadulterated sense. As Annie Dillard observes, “The present of my consciousness is itself a mystery which is also always just rounding a bend like a floating branch borne by a flood.” And in the context of this work, there are at least two bends: I am writing about authors that are writing about experience. It would be folly to think immediacy is being dealt with directly. Affect is always already mediated, but this neither means that we should dismiss what happens in the present, nor entirely give up hope of discussing it.

Massumi acknowledges fully that even before we talk about affect, before we filter phenomena via language, the very process of becoming cognizant of it complicates matters. We are warned: “[S]ensation is never simple. It is always doubled by the feeling of having a feeling. It is self-referential. […] It is an immediate self-complication. It is best to think of it as a resonation, or interference pattern.” This has implications for this work, first of all, in that I make no claim to access affect directly. Indeed, as will be seen, I accord to wonder the status of affect which precedes

46 Massumi, Parables for the Virtual, 13–14.
and makes way for other affects. This resonance, far from being a conceptual hurdle, is essential to it. But this “interference pattern” inherent to affect also means that looking at affective elements of writing is as good a way as any of investigating affective engagements in the ecosphere. The sooner one reconciles oneself to the idea that consciousness, let alone communication, of even the most basic sensations inevitably involves mediation, the more comfortable one becomes contenting oneself with affective traces in writing that may be picked up, followed, but that have no proper end to their reverberation or origin. Certainly, the texts here not only attempt to conjure immediacy but also contain meta-reflections on affective experience.

The second implication of the inevitable mediatedness of affect concerns its place in nature/nurture discussions. Our affective engagements with the environment can neither be described as entirely pre-cognitive (innate) nor entirely conscientious, because of this very doubling-back of sensation described by Massumi. This allows us here not only to view approaches that insist on the naturalness of particular modes of human/environment interaction, such as Wilson’s own sociobiology, suspiciously, but also those that are perhaps overly constructivist. Following Spinoza, we do not know beforehand what a body or mind can do, we cannot circumscribe the range of affects, yet we also cannot say that with everybody, not to mention every body, everything is possible. Potentials are neither fully ours, nor assigned to us, neither fully innate nor learned. This project does not concern itself with why we attend to certain things, or to what end, only with the fact that we attend to them in the first place. The focus shifts, then, from the nature/nurture dichotomy, from origins, to the relation itself.

It is also important to note that this understanding of affect is not synonymous with emotion, although emotion must of necessity possess an affective basis. Massumi has described “perception and cognition” as the “capture and closure of affect,” and writes that “[e]motion is the most intense (most contracted
expression of that capture).” We may, then, differentiate affect from emotion based, first of all, upon the idea that emotion involves a becoming-conscious of sensation or affect, and, secondly, the notion that emotion is somehow a more concentrated, perhaps even a more coordinated, manifestation of affect. If affect is fleeting, emotion is, in other words, less so.

The distinction between affect and emotion becomes even more meaningful when we consider emotion as affect interpreted, or “the ideological attempt to make sense of some affective productions.” Massumi defines emotion as “the sociolinguistic fixing of the quality of an experience which is from that point onward defined as personal,” and for this reason, it is always “qualified intensity,” “intensity owned and recognized.” Emotion is thus of the subject, while affect, strictly speaking, cannot be confined to it. Certainly a whole arsenal of words for wonder and enchantment do something to fix them as emotions, as qualified intensities that persist in time, but I will argue that the texts in this work focus on a more impersonal, incoherent, unsentimental wonder — not as romantic indulgence in superficial emotion, but a more fleeting feeling or sensation. What is of primary interest, then, is wonder as affect rather than emotion.

An important question is whether one might discuss pre-emotional affective productions without recourse to the language of emotion. In other words, we ought to critically assess whether the immediacy of affect might somehow find semiotic preservation. To imagine that writing does not ideologically invest affective productions is certainly naïve, and yet this project loses meaning if we cannot somehow make reference to the world of sensation and the virtual. But what we find in the corpus is not simply writing that references particular “affective assemblages.” It may take this as a starting point, but it then turns to concepts like attentiveness and attunement, and often openly

47 Massumi, Parables for the Virtual, 35.
49 Massumi, Parables for the Virtual, 28.
refuses the task of fully communicating the individual affective experience. By and large, then, these texts make a concerted attempt to avoid the emotional or sentimental, and opt, rather, to serve as a guide to exploring intensities, whether those happen to be microscopic or cosmological.

2.2.2. Immanent subjectivity
What’s most significant about the affective encounter for ecological ethics is its disruptive or transformative potential. Rather than reassuring of us of our human relation to the ecosphere, affect ought, at least sometimes, to challenge it. Davide Panagia, in the realm of the political, casts affective experiences as “moments of breakdown,” which “interrupt the assurances that guarantee the slumber of subjectivity.”50 These stand in stark opposition to, for instance, pleas to save the children, which, as Edelman reminds us, rely on the belief that the contemporary social order is worth perpetuating. It bears mentioning, however, that despite the potential affect possesses for spurring us to revise our conceptions of the world, it does not do so in any way that is uniform or predictable. Affective ecologies, on their own, cannot form the basis for the kind of ecological ethics that could, for instance, be legislated. They do form, however, an ideal position for exploring the depth and breadth of human relations to the ecosphere.

A focus on affective dimensions of the ecological thus frees us from the binds of a future-oriented ethics because it does not make the same assumptions about the human, let alone the subject, that more traditional ecologies do. These are ecologies that no longer speak the language of responsible citizenship, that place no special focus on the children or the perpetuation of the species. Affective ecologies address registers that undeniably passionate cries to save the future, à la Trilford or Suzuki, leave entirely unaddressed. Although these pleas are nothing if not intensely emotional, they rely on very limited notions of the

human, drawing, at one and the same time, on an idea of the
anthropos as the selfless creature with a (perhaps rather cavalier)
faith in the ability and desire to maintain and perpetuate the
Western progress narrative, and notions of the human as merely
a biopolitical entity that must continue to proliferate at any cost.
The study of affect, on the other hand, is not limited strictly to
the human and certainly does not make the same assumptions
about legitimate reasons to act. It may not, in fact, help us imme-
diately to act at all, but it does illuminate precisely how narrow
our definition(s) of the human have become. Michael Hardt, in
a spin on the classic Spinozan dictum, states, “We do not know
in advance what a body can do, what a mind can think — what
affects they are capable of. The perspective of the affects requires
an exploration of these as yet unknown powers.” 51 The “perspec-
tive of the affects” is not interested in entirely abandoning the
human, but enlarging it, providing, “a new ontology of the hu-
man or, rather, an ontology of the human that is constantly open
and renewed.” 52 Indeed, it is the very acknowledgment of our
creatureliness that contains the potential for the transformation
of the human. Traditional environmental ethics preclude this
radical ontological shift.

2.2.3. Scientific entanglements
Given that so much of this project rests on scientists who are
profoundly mixed up in that which they examine, scientific in-
quiry ought also to be placed in this vital/incorporeal material-
ist or agential realist framework. Karen Barad, herself trained
as a scientist and the originator of the term “agential realism,”
does just this. Knowing, for her, is entirely tangled up with ex-
perience, and the activity of “wondering at” slips ceaselessly
into “wondering with.” Indeed, she questions the very models of
objectivity and distance the scientists in this project hold dear,

51 Michael Hardt, “Foreword: What Affects are Good For,” in The Affective
Turn: Theorizing the Social, eds. Patricia Ticineto Clough and Jean Halley
52 Ibid., x.
but boldly elucidates the entangled science that, at least in their most popular works, they appear to practice.

The agential realist ontology is, in its emphasis on perpetual becoming and broadening of the category of agency, strikingly similar to incorporeal and vital materialist accounts. Barad writes, “phenomena — whether lizards, electrons, or humans — exist only as a result of, and as part of, the world’s ongoing intra-activity, its dynamic and contingent differentiation into specific relationalities.”53 “We humans,” it follows, “don’t make it so, not by dint of our own will, and not on our own. But through our advances, we participate in bringing forth the world in its specificity, including ourselves.”54 Barad explains, again and again, that there is no such thing as human exceptionalism. We do not wander a globe that, were it not for us, would operate just so; we participate fully in the formation and co-creation of what we call nature. In this way, too, agential realism calls for a radical non-anthropocentrism: We do not merely do things to matter. Barad insists, “Bodies are not of the world; they are part of the world.”55 She goes on to clarify:

The world is an ongoing intra-active engagement, and bodies are among the differential performances of the world’s dynamic intra-activity, in an endless reconfiguring of boundaries and properties, including those of spacetime. Technoscientific and other practices entail space-time-matter-in-the-making. Nothing stands separately constituted and positioned inside a spacetime frame of reference, nor does there exist a divine position for our viewing pleasure located outside the world. There is no absolute inside or absolute outside. There is only exteriority within, that is, agential separability. Embodiment is a matter not of being specifically

54 Ibid.
55 Ibid., 176.
sitated in the world, but rather of being in the world in its
dynamic specificity.56

This is another way to describe the condition of immanence, which, after all, Deleuze described as “a life.”57 We are not only of the world (are not only brought forth by it), but we, too, bring it forth. We do not only watch the actual drop like a fruit from the virtual, but ourselves cause it sometimes to drop.

But there is more to Barad’s agential realism than the contention that we, the human, participate constantly in making, re-making, and un-making the world. She also insists that other actors, known and unknown to us, continually accomplish the same thing. As a result, there is no properly passive object of human knowledge. She writes, “There is more to nature than ‘nature-as-the-object-of-human-knowledge. The latter constitutes a re-veiling (which provokes the seeming need for revealing) of nature, yet again.”58 Making discrete actors or phenomena the object of human knowledge entails the impossible task of cloaking only them, followed by a prestige in which they are, as if by magic, brought back into the world. The way in which we know is not only very selective for Barad, then, but neglects the intra-activity of that which we deem “object.” Barad observes:

Boundary-making practices do not merely pick out the epistemic object,backgrounding the rest. And scientific practices are not merely practices of knowing, and the knowledge produced is not ours alone. Even in direct challenges to Western philosophy’s traditional conceptions of epistemology, there is a tendency to continue to think of knowers as human subjects, albeit appropriately hooked into our favorite technological prostheses.”59

56 Ibid., 376–77, emphasis in original.
58 Barad, Meeting the Universe Halfway, 378.
59 Ibid.
Knowing is not nature revealing herself to us, but a set of material practices that give us limited insight into the world ongoing intra-activity. Subject and object, therefore, are not pre-existing categories, but emergent ones “that are enacted.”

This alternative epistemological and ontological account already has important implications for science as a way of knowing. The most obvious is that “To the extent that humans participate in scientific or other practices of knowing, they do so as part of the larger material configuration of the world and its ongoing open-ended articulation.” Knowing occurs through intra-action. This becomes important for the works in this project because they present the human and especially the scientist as not only deeply embedded in the field and the world, but as themselves part of what is so often viewed merely as background for human dramas. As we will see, wonder and enchantment often “happen” at precisely the moment that object is revealed as possessing agentic capacities. In these instances, the boundaries are redrawn; the scientist ceases to occupy a fixed and defined position from which he or she can be observed and, instead, dissolves in the world’s intra-activity. And Barad insists, time and time again, that we, the humans, the animals, the strictly “living,” do not possess a monopoly on agency. For her, “agency is understood as an enactment and not something someone has.” Science, at its most progressive, involves the recognition of nonhuman agencies — those enactments that happen because of, but just or more often, despite us, which we in turn struggle eternally to understand with our own intricate agency. Knowing is possible not only because we choose to manipulate matter in the world, but because that matter is active to begin with.

The second implication Barad’s agential realism holds for science is that it means we do not always “murder to dissect.” While Barad adheres to a realist conception of science in main-

60 Ibid., 359.
61 Ibid., 379.
62 Ibid., 214.
taining that it involves the investigation of things really happening (she speaks of “the objective existence of particular material phenomena”), she also maintains: “Objectivity is a matter of accountability for what materializes, for what comes to be. It matters which cuts are enacted: different cuts enact different materialized becomings.”64 Objectivity is not a stance, but a practice, and one that must be negotiated and adjusted again and again in order to produce phenomena that cohere to or build upon previous bodies of knowledge. As a scientist, one does not merely operate on inert material in order to reconfirm what was previously thought. Rather, “different cuts enact different materialized becomings.” We do not merely murder to dissect, or kill in order to know; we also vivisect, create and nurture life, in order to see what is possible, to know more.

This entangled science, as we shall see, is a profoundly useful complement to Massumi and Bennett’s vital/incorporeal materialism. What Barad succeeds so well in doing is exploding the myth of knowledge creation happening above and apart from the object of that knowledge without wholly discounting science itself. Science explains and discovers phenomena, but not by dint of its apartness. It may seek to understand “the world’s ongoing intra-activity,” but it cannot do so away from or above it. Scientific practice involves actualizing potential just as much as it involves the study of the actualization of these potentials.

What is striking about both Barad and Bennett’s work is that ontological claims are nearly always followed by ethical ones. Understanding intra-activity and vitality always entails the recognition of and respect for the nonhuman, and vice-versa. Barad writes: “Learning how to intra-act responsibly as part of the world means understanding that “we” are not the only active beings — though this is never justification for deflecting our responsibility onto others.”65 Recognizing nonhuman agency, inevitably, plants the seeds for a non-anthropocentric ethics. Bennett explores this even more explicitly:

64 Barad, Meeting the Universe Halfway, 361, 214.
65 Ibid., 391.
Why advocate the vitality of matter? Because my hunch is that the image of dead or thoroughly instrumentalized matter feeds human hubris and our earth-destroying fantasies of conquest and consumption. [...] The figure of an intrinsically inanimate matter may be one of the impediments to the emergence of more ecological and more materially sustainable modes of production and consumption.66

Recasting the world as dynamic becoming, of which we the human are only a part, means that we have no choice but to care about the other actors. Certainly, what it means to “meet the universe halfway, to take responsibility for the role that we play in the world’s differential becoming”67 is far from a straightforward matter. But Barad and Bennett both insist that the first step is to care. The enchanting tactics employed by the works of popular science discussed here, I will argue, aim to accomplish this first step. They do so by exploring and inducing wonder, a phenomenon that involves a temporary suspension of subjectivity and with it, the specter of objectivity.

2.3 New Attunements: Understanding Affective Wonder

Already, then, one might see how “a science that meets the universe halfway” — that takes up a vital materialism — might run counter to the disenchantment narrative. To understand how this operates in the works investigated here, however, it first bears examining how we can understand wonder as the action of reenchantment. This section begins with a broad approach to wonder, using its loosely phenomenological articulation to connect it provisionally with affect, and to explore it as both a

67 Barad, Meeting the Universe, 396.
disruptive phenomenon and something cultivatable and related to habit. The second section then focuses more explicitly on scientific wonder, taking up Uexküll’s notion of the Umwelt as a way to understand the novelty with which wonder confronts us.

2.3.1. Wonderstruck, again and again?
That “wondering” happens in the present takes no great effort of imagination, but tracing its precise relation to the affective involves some work. As the introduction touched upon, Martha Nussbaum refers to it as one of the only emotions that does not qualify as eudemonistic, or connected to one’s own “goals and projects.” Instead she claims it is a responding to “the pull of the object,” when the “subject is maximally aware of the value of the object, and only minimally aware, if at all, of its relation-ship to her own plans.” Although, as will be shown, subject and object become problematic divisions when speaking about wonder, particularly in an ecological context, one can at least take away from this that wonder forms a kind of intense engagement with the present, in which our orientation towards the future (“goals and projects”) is at least partially suspended.

Indeed, in many accounts, that of the seventeenth-century painter Charles Le Brun included, wonder is a kind of paralysis in the face of the new or exceptional. In a 1668 lecture, Le Brun refers to wonder as “the first of all passions,” continuing:

Wonder is a surprise which causes the soul to consider attentively objects which seem to it rare and extraordinary, and this surprise is sometimes so powerful that it pushes the spirits towards the place whence the impression of the object is received, and they are so much occupied in considering this

69 Ibid., 54.
70 Ibid.
impression that there are none left to pass thence into the muscles; the body therefore remains motionless as a statue.\textsuperscript{71}

My contention here, and this aligns well with Le Brun’s account, is that wonder constitutes a special kind of affect, a kind of primary affect that enables the experience of a whole host of others.\textsuperscript{72} Affective wonder as dealt with in this work may be expressed as \textit{the realization that the affects one is undergoing are new}, or, expressed in slightly different terms, it might be called \textit{a sudden attunement to affects that one had not been attuned to before}. More Deleuzian vocabulary, which we will return to in the next subsection, might cast it as something like a sensitivity to new becomings. As such, wonder is precipitated as much by transformative experience as by intention and practice. I have chosen, in this section, to focus on the work of phenomenologist Howard Parsons, largely because he is one of the few theorists to mention wonder, at least its more immediate variants, more than peripherally,\textsuperscript{73} and Jakob von Uexküll, who provides a much more explicitly affective framework and upon whom Deleuze and Guattari also drew heavily.\textsuperscript{74}


\textsuperscript{72} In this it is also distinctive from the sublime, which signals the supposed triumph of reason over the unassimilable — when “the mind has been incited to abandon sensibility” (see Kant’s \textit{Critique of Judgment}, trans. James Creed Meredith [Oxford: Oxford University Press, 2007], 76). This work has attempted to avoid, as much as possible, language related to the sublime, insisting rather on the manner in which the subject does not entirely come to terms with the infinite.

\textsuperscript{73} Nussbaum, despite claiming to discuss wonder in \textit{Upheavals of Thought}, actually does so on precious few occasions. We will return to a few of her remarks at the end of this chapter, however.

\textsuperscript{74} Doubtless a much more exhaustive history of the concept, especially concerning Renaissance conceptions of wonder and the \textit{Wunderkammer}, would be possible, but time forces a certain amount of selectivity. See Lorraine Daston and Kathrine Park, \textit{Wonders and the Order of Nature, 1150–1750} (New York: Zone Books, 2001).
But before delving into the philosophical treatment of wonder, the lay definition also bears mentioning. In the *Oxford English Dictionary*, “wonder” as a noun may be:

the emotion\(^75\) excited by the perception of something novel and unexpected or inexplicable; astonishment mingled with perplexity or bewildered curiosity. Also, the state of mind in which emotion exists; and an instance of this; a fit of wonderment.\(^76\)

Already a dual character of wonder is implied here: It involves, on the one hand, a certain distance from the stimulus, a realization of novelty, but this also constitutes, on the other hand, an experience in and of itself. One might think back to Brian Massumi’s assertion that sensation “is always doubled by the feeling of having a feeling,” and, as such, is more accurately a kind of resonating than a phenomenon discretely captured.\(^77\)

More speculative etymology links wonder to the Old English *wundor*, which Parsons writes “might be cognate with the German *Wunde* or wound.”\(^78\) Though Parsons published his “Philosophy of Wonder” in 1969, his rhetoric, at times, appears strikingly similar to more contemporary theorists who, like Davide Panagia, insist on the disruptive nature of affect. Parsons continues the discussion of wonder as wound:

It would thus suggest a breach in the membrane of awareness, a sudden opening in a man’s system of established and expected meanings, a blow as if one were struck or stunned.

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\(^{75}\) Although the word “emotion” is employed here, my contention is that wonder, as affect, can just as easily be described as a sensation. Certainly ideological investment renders it something more like an emotion, but it may also describe states that are less coherent.


\(^{77}\) Massumi, *Parables for the Virtual*, 13, 14.

To be wonderstruck is to be wounded by the sword of a strange event, to be stabbed awake by the striking.79

Wonder, here, consists of something distinctly different from “wondering.” Although curiosity may render the perception of a “strange event” more likely, wonder as wound involves a precognitive element, although it is never an exclusively precognitive phenomenon. Wonder, here, speaking figuratively, “happens” not merely when some aspect of the world knocks, but also when it steals in, and subsequently comes face to face with the subject. (This does not necessarily mean, as we will see in a moment, that wonder comes unbidden.) Wonder can thus be termed precognitive only to the extent that, in whatever way, we cannot account for or order it, but it generally involves a retrospective recognition of the limits or inadequacy of the cogito and some process of assimilation that must be cognitive in character. For Parsons, this initial shock is always followed by an attempt by the cogito to assign meaning to and assimilate the experience.80 While I do not necessarily disagree with this sense-making process, this book and this chapter concern themselves with this first and more elemental stab: “the spark of excitation leaping across the gap between man and the world.”81

Parsons is certainly not the only author to frame wonder as an instance of the nonhuman world invading what is popularly perceived as human. Rachel Carson, the famed author of Silent

79 Ibid., 85.
80 Significantly, however, it is not the assimilation, the “aha” moment, as with Cartesian models of wonder, that produces or motivates the phenomenon itself. For an exhaustive description of Cartesian wonder, which I will not deal with substantively in this work, see Philip Fisher’s Wonder, the Rainbow, and the Aesthetics of Rare Experiences (Cambridge: Harvard University Press, 1998). In connection with these very different understandings of wonder, Robert Fuller makes a distinction between the dispositions of curiosity, always oriented in some way towards mastery of the surroundings, and wonder, which focuses on “intrinsic value or meaning.” See Robert Fuller, Wonder: From Emotion to Spirituality (Chapel Hill: The University of North Carolina Press, 2006), 8–9.
81 Parsons, “Philosophy of Wonder,” 85.
Spring, refers to wonder as a “recognition of something beyond the boundaries of human existence.”82 Here, with Carson’s attempt to articulate a particularly non-anthropocentric phenomenon, we draw close to Deleuze and Guattari’s “non-human becomings of man,” in which we “are not in the world, we become the world; we become by contemplating it.”83 Wonder, in other words, involves the suspension of the systems that we so often believe constitute us as discrete subjects—language and culture—even if it is these same systems that sometimes allow the experience of wonder to begin or help to make sense of it later. It is no accident, then, that experiences of wonder often precede a more principled engagement with ecological interconnectedness; it flies in the face of our anthropocentrism.

Parsons, notably, also recognizes degrees of wonder. At the one end, and exhibiting a milder form, is a type that elicits merely a “signifying interest.”84 It invites the subject to make sense of the contents of the experience, to place it in some sort of signifying framework. The other end of the spectrum is composed of the basically unassimilable, and “may be so affectively unifying and overmastering that the symbolic meaning cannot grasp or accommodate it; it becomes, in the report of the mystic, ineffable.”85 Parsons makes the further distinction between these two types or degrees: the wonder associated with a “signifying interest” involves an active, fully conscious subject. This more profound kind of wonder, involving an element of surprise, is, on the other hand, described as follows:

To be surprised (super + prehendre) is to be taken over and taken up. It is to be subjected to an innovating experience or creation whose occurring or novelty is beyond one’s con-

84 Parsons, “Philosophy of Wonder,” 93.
85 Ibid.
scious control and is felt vividly. Within such wonder, however, lies the disposition to act and to take a part in the forming of one’s experience. Wonder of this type is thus a kind of suspended animation, a balance and a tension between a passive mood and an incipiently perceptual and active mood. In some mystical experience the latter mood appears to be more or less nullified.86

Wonder, as the experience of the ineffable, I would like to suggest, not only means that the “passive mood” acquires the upper, or at least equal, hand in experience, but that it shakes the very foundations of the “active mood” itself. This becomes especially pertinent when discussing ecological wonder, where revelations regarding energetic and material interconnectedness swiftly undermine supposedly commonsense notions of human agency and discreteness.

It is no accident, either, that Parsons associates at least some varieties of wonder with mystic experience. Varadaraja Raman argues that mystic experience includes a “mysterious plunge into an aspect of the world that is sometimes described as oceanic” and that “the becoming conscious of a normally inaccessible aspect of the universe,” also noting that it need not be tied to religion in the traditional sense (i.e. those systems concerned with prophetic revelation).87 This is not far at all from our working definition of wonder as a sudden attunement to affects that one had not been attuned to before. Mystic experience seems to constitute, or be constituted by, especially dramatic or intense experiences of wonder.88

86 Ibid., 94.
88 In order to limit the scope of inquiry, this work does not engage with Eastern philosophy; nevertheless, there are doubtless countless connections to be drawn between descriptions of mystic experience found within any number of Eastern sources and the affectively novel and wonderful. Robert Fuller, for instance, points to the concept of darshan in the Indic tradition, or “the ritual act of seeing divinity,” which goes far beyond the emotions
And it should also be noted that the second kind of wonder mentioned by Parsons, the one akin to mystic experience, is not always “wondrous” in the sense of pleasant. The nature writer Annie Dillard has made a career in masterfully articulating moments when articulation fails and either terror or exaltation sets in. She describes the witnessing of the total eclipse, for instance, as “like dying, […] like the death of someone, irrational, that sliding down the mountain pass. It was like slipping into fever, or falling down that hole in sleep from which you wake yourself whimpering.”

In this particular episode, she regains her composure only when another witness describes the obscured sun as looking “like a Life Saver up in the sky.” The eclipse may have allowed her to glimpse, and indeed become aware of, the goings-on of the cosmos, but the force of it overshadows terrestrial life. Negative experiences of wonder may indeed be alienating or nullifying.

What is key to Dillard’s encounter, as well, is the relation between the precognitive, here the ineffable experience of the eclipse, and the cognitive, here the attempt to place it back within the realm of the social, within language. Dillard encounters relief only when the event’s immediacy, its affective dimensions, become expressible, declaring, “All those things for which we have no words are lost.” She does not specify what might be lost in the attempt to find words for things, i.e., whether the ability to subsume the event linguistically lessens its initial impact.

Parsons, on the other hand, claims that it does, arguing that the physical and metaphorical flattening out of experience is responsible for the ordinary. Ordinary experience is accomplished by “the flattening out of the wild, erratic flora and protruding peaks and outcroppings — by blueprints, bulldozers,

of curiosity or surprise popularly associated with wonder today (Wonder, 10–11).

90 Ibid., 23.
91 Ibid., 24.
superhighways.” 92 It does not take too much effort to imagine that this “wild, erratic flora” and these “protruding peaks” are conceived of as major sources of wonder. Mechanisms for understanding phenomena can also constitute a kind of flattening here; Parson remarks that, before they became well understood by a large percentage of the population, thunderstorms, eclipses, and comets also elicited wonder. 93 The effort to draw an experience into the signifying system, for Parsons, also inevitably constitutes an effort to render it ordinary.

Where Parson's argument becomes most interesting, however, is when he talks about habit. It is not as if ordinary experience is synonymous with habit, and wonder always disruptive of it, but “fits of wonder” are themselves often determined by habitual mechanisms: “Thus the conditioning effects of habit tend to determine not only what we regard as ordinary, but also what we are ready to respond to as wonderful.” 94 Thus, a writer such as Dillard, who has staked her existence on the experience and subsequent articulation of “fits of wonderment,” might be much more likely to experience wonder during an eclipse (despite understanding the mechanics of it perfectly well) than someone who is not accustomed to looking up at the sky.

As I will discuss later, the notion that explicability detracts from the wonderful is expressly challenged by both Sagan and Wilson. 95 The two authors, in fact, argue that understanding increases wonder. My argument forms a kind of compromise. I contend not that understanding is a flattening out, nor that it possesses the ability to make experience more wondrous, but that it is always more complex than that. Understanding, like the experience of wonder, can itself alter habits and forms of attention. One must acknowledge that the ability to place expe-

92 Parsons, “Philosophy of Wonder,” 86.
93 Ibid.
94 Ibid.
95 Not to mention Richard Dawkins. His Unweaving the Rainbow (New York: First Mariner Books, 2000) is a lengthy refutation of Keats’s poetic claim that “Newton had destroyed all the poetry of the rainbow by reducing it to the prismatic colours” (x).
riences of the ineffable, the marvelously precognitive, in a signifying framework, might preclude a certain intensity in future experiences along these lines. But the authors I deal with also consistently imply that, both in terms of scale and intricacy, life and the cosmos are inexhaustible. There is no such thing as fitting “it all” into a signifying framework, and the drive to discover and place the ineffable may in fact put one more often in contact with it. One may, in other words, talk about “the practice of wonder” non-oxymoronically. If we return to the affective, this means that “transformation and sedimentation”

96 are not always at odds with one another. Wonder may indeed beget wonder, and the habits that allow us access to that outside ourselves do not necessarily detract from the intensity of the experience.

But still, although Parsons gives us an idea of how we might conceive of the concept of wonder and the experience of it, however passive or active, extraordinary or conditioned by ordinary experience, he does not exactly give us a way to think novelty, of precisely how the subject encounters something outside itself.

2.3.2. When Umwelten collide: wonder with Uexküll

One may bypass these binaries of the active versus passive subject and ordinary experience, or sedimentation, versus the experience of wonder, or transformation, by looking back to the work of Jakob von Uexküll, an ethologist active in the late nineteenth and early twentieth centuries who was revived by Deleuze and Guattari. Uexküll himself never discusses wonder explicitly, but his notion of the dynamic Umwelt, or the subjective surroundings of an organism, serves to ground the notion of wonder more effectively in the affective and allows us a way to conceive of new affects. Indeed, wonder may be further elaborated in Uexküll’s terminology as the experience of the expansion

of the individual Umwelt\textsuperscript{97} via the experience of new affects. For Uexküll, this is a natural, and mostly inevitable, process:

As the number of an animal’s performances grows, the number of objects that populate its Umwelt increases. It grows within the individual life span of every animal that is able to gather experiences. For each new experience entails an adjustment to new impressions.\textsuperscript{98}

Thus, the Umwelt of the tick, supposed by Uexküll, with its three limited affects (climbing toward the light, dropping from a branch upon smelling mammalian sweat, burrowing and latching on where it is warm)\textsuperscript{99} is extremely small, and the capacity for the expansion of this Umwelt, or wonder, is likely limited at best. While nonhuman animals could certainly also experience wonder in this framework, the human is perhaps the most interesting subject because there are, at this point in time, virtually no restrictions to the boundary of the human Umwelt. This does not mean that we possess the capability to expand our actual territory and colonize the planets of faraway suns, but it has rather something to do with the fact that objects and phenomena in space may strike us. Though a comet may be oblivious to the whole episode, any number of humans may have an encounter with it (whether with the naked eye or with the aid of technologies) that produces wonder.

Indeed, Uexküll firmly insists on the significance of virtual Umwelten. These “magic Umwelten” not only exist for chil-

\textsuperscript{97} It must be noted, however, that despite using the word “expansion,” this does not entail any traditional kind of expansionism. Rather than only, or even necessarily, including growth in the sphere of perception in spatial terms, expansion of the individual Umwelt can mean increased attunement at any level. New affects may be experienced on the micro-level, just as on the cosmic, and over longer stretches of time just as easily as in fleeting microseconds.


\textsuperscript{99} Ibid., 322–26.
dren and “primitive peoples,” but also for the “highly cultured European”\textsuperscript{100} and potentially many nonhuman animals. To illustrate how magic \textit{Umwelten} operate, Uexküll examines the same subject, an oak tree, as viewed by various actors: For the forester, the oak tree is merely a resource, “a few cords of wood,”\textsuperscript{101} despite the fact that its knobs look like a human face. For a little girl, however, “[t]he whole oak has become a threatening demon.”\textsuperscript{102} But Uexküll does not stop at the human. For the fox, the oak tree’s roots provide a roof and protection.\textsuperscript{103} The owl, similarly, seeks shelter under the branches, whereas for the squirrel, the oak is many things, including, “a wealth of comfortable jumping boards”\textsuperscript{104} while for the ant the oak is an entire hunting ground. For the bark-boring beetle, which eats the oak, and the woodpecker, which eats the beetle, the oak is different still. Uexküll’s point, in the end, is this:

Should we attempt to epitomize all the contradictory properties which the oak tree as an object displays, only chaos would result. And yet they are all but parts of a subject firmly structured in itself, which bears and harbors these \textit{Umwelten}—not comprehended and never discernible to the builders of these \textit{Umwelten}.\textsuperscript{105}

\textit{Umwelten} are virtual environments populated by actual objects that themselves inevitably possess virtual dimensions. That they are not transparent to those who live them does not mean that changes within or to them go unnoticed, however. Thus it is with wonder, which is the expansion of the boundaries of the magical or virtual \textit{Umwelt} made perceptible. In many cases, in fact, it is when the subject, or explorer-scientist, discovers one of the other manifold properties of a familiar object that wonder

\textsuperscript{100} Ibid., 376, 378.
\textsuperscript{101} Ibid., 378.
\textsuperscript{102} Ibid., 384.
\textsuperscript{103} Ibid., 386.
\textsuperscript{104} Ibid., 386–87, 387.
\textsuperscript{105} Ibid., 388.
“sets in.” The human may marvel at the squirrel’s acrobatic use of the oak tree as much as the woodpecker’s efficient drilling of it for food.

The very end of Uexküll’s essay concerns the Umwelten of scientists, and, as the remainder of the chapter examines the attempts of two select scientists to share the expansion of their own Umwelten, the passage is worth quoting at length. The Umwelten of scientists reveal, perhaps, just how radically different the Umwelten of members of a single species may become. Uexküll writes:

High on his tower, as far as possible from the earth, sits a human being. He has so transformed his eyes, with the aid of gigantic optical instruments, that they have become fit to penetrate the universe up to the most distant stars. In his Umwelt, suns and planets circle in festive procession. Fleet-footed light takes millions of years to travel through his Umwelt space.

And yet this whole Umwelt is only a tiny sector of nature, tailored to the faculties of the human subject.

With slight alterations, the astronomer’s image can be used to gain a conception of the deep-sea researcher’s Umwelt. Only here, instead of constellations, the fantastic shapes of deep-sea fish wheel around his sphere with their uncanny mouths, long tentacles and radial light organs. Here again, we glance into a real world, which constitutes a small sector of nature.106

The figure of the scientist may be unique, insofar as he or she is trained to recognize the constraints of his or her Umwelt. The scientist’s supposition must routinely rest on the idea that, however valid the “real world” observed may be, it only “constitutes a small sector of nature.” Thus scientific work consists, in countless different ways, of the expansion of this small sector: the collection of data, the refinement of instruments of observation,

106 Ibid., 389–90, emphasis added.
cooperation with other scientists, and methods of synthesizing data. When this small sector, the individual or collective scientific Umwelt, is expanded, it is indeed a cause or occasion for wonder. This affect, especially given the heavy literal and figurative public investment in science, is not limited to the researchers themselves. As a dramatic case in point, one might cite the enormous public interest in space exploration, which “can be identified even in national contexts lacking direct access to spaceflight before the late 1970s,”107 and the twentieth-century romantic identification of the Space Age as “the greatest age of all.”108 One need not even experience new affects firsthand in order to wonder. An image, a report, even an inkling that someone, or something that will report to someone (in the case of a probe), is glimpsing or sensing something that has never before featured in a human Umwelt suffices in the context of space exploration.

Moreover, Uexküll’s own invitation to explore the worlds of nonhuman creatures on their own terms, to expand the human Umwelt by stepping into the Umwelten of others, also provides occasions for wonder. Brett Buchanan, a scholar of Uexüll, says of his Stroll through the Environments of Animals and Humans, “No, it may not be a new science, not nearly so ordinary and pedantic, but it is indeed something wondrous. New worlds arise before our eyes, through our sensations, in our imaginations.”109 Uexküll asks us, at the very least, to imagine new affects; who is to say, then, that one does not experience them? This is, in the truest sense, an anti-anthropocentric effort. Buchanan continues:

Rather than conceiving of the world according to the parameters of our own human understanding— which, histori-

108 Ibid., 219.
vital reenchantments

Uexküll asks us, in other words, to conceive of other intelligences, by which we must understand something far different than simply other modes of cognition. These are entirely alien affective worlds, in which sights and smells (not to mention a host of other senses that humans likely do not possess) do not cohere with what is familiar to us. Even at an early age, for instance, the realization that even one's own cat or dog sees differently is an occasion for wonder.

But the acquaintance with and recognition of other Umwelten goes even further than this; it is not only a matter of familiarizing oneself with other realities, other modes of “being,” but also a matter of seeing that the organism and its affects are inseparable. This is what Deleuze & Guattari take from Uexküll, and also what they mean, potentially, when they declare in A Thousand Plateaus that “[t]he organism is the enemy.” Bu-

It is a curious call to arms and one that has nothing to do with a dislike of organisms or animals. It is nothing of the sort. Rather, it is more an issue of “going beyond the organism” [...], of penetrating past the phenomenological interest in the “lived body” and “being-in-the-world,” in order to discover the ontological processes that create what we are accustomed to calling the “organism.” The organism is the enemy."

110 Ibid., 2.
112 Buchanan, Onto-Ethologies, 151.
Like all revolutionary cries, this calls for an assault on small-mindedness. The interest in other modes of being is not enough here, because it assumes, at least on some level, that we exist in the same Umwelt. Deleuze & Guattari, along with Uexküll, invite us not only to encounter radical difference but also to incorporate it into our own modes of moving and perceiving in the world — hence the emphasis on becoming(s). This, at last, fully accounts for the wound Parson locates in wonder, and the notion that, even when we do manage to encase wonder in some sort of signifying framework, to craft an adequate explanation, we no longer encounter the same subject. Wonder, even accompanied or perhaps enhanced by understanding, as the experience of new affects through new Umwelten, means that the subject never comes out the same.

It does not require a great deal of effort to imagine how a biologist, namely Wilson, writing a work of popular non-fiction, might mobilize this kind of wonder in his own writing, particularly when he investigates that most alien of creatures, the leafcutter ant. What perhaps requires slightly more of a stretch is the effort to understand how Sagan’s much less earthly or Lovelock’s much more systemic engagement is also wonder-driven. I argue here that, as focused as Wilson is on revealing the importance of Umwelten that are not our own, Sagan and Lovelock are equally focused on what may be made of the human Umwelt. Wilson and Lovelock ask us primarily to protect, Sagan to maintain the spirit of exploration, but each of the scientists insists on these activities because they allow us to wonder. Wonder here is never simply instrumental but constitutes an end in and of itself.
The works dealt with here discuss wonder and its analogs\textsuperscript{113} nearly perpetually. The popular science writer, the post-in-scientist, becomes in these works especially a machine built for wondering. The mundane and inert are exploded as unscientific myth, and the reader is ceaselessly, at times exhaustingly, presented with a world teeming with an infinity of singular affects. What the next chapters present are the unique but interrelated ways in which the texts engage with wonder and reenchantment, interrogating, in each of these cases, how these practices are linked back to an environmental politics.

Although there is certainly plenty to keep one busy on the formal level in these texts, I have conscientiously shied away from approaches that would have me dwell exclusively or mostly on this.\textsuperscript{114} Instead, in pursuit of a framework that would allow

\textsuperscript{113} A more technical distinction could certainly be made between wonder, marvel, awe, and enchantment, particularly on etymological grounds. The authors I deal with, however, use these concepts interchangeably, and, for purposes of not making my own investigation impossibly narrow, I do, too. Nevertheless, it is interesting to note that while the exact derivation of wonder is unknown (see the OED entry for “wonder, n.” cited in note 76 above), marvel is linked etymologically to the miraculous, awe to fear, and enchantment to magic. See, respectively, Oxford English Dictionary Online, s.vv. “marvel,” https://en.oxforddictionaries.com/definition/marvel, “awe,” https://en.oxforddictionaries.com/definition/awe, “enchantment,” https://en.oxforddictionaries.com/definition/enchantment.

\textsuperscript{114} I allude here to reader response theory, which, in theory at least, has fascinating applications with regard to popular science, in which the reader is so often addressed directly and involved in the text, as well as narratological approaches. As previously stated, however, while these works do have some narrative aspects, this investigation is much more concerned with where these narratives, understood in a very conventional sense, are interrupted by the affective — by experience that does not quite fit into the conventional stories of cosmic or biological evolution. I have also avoided deconstructive approaches, despite their potential for exploring the places in which the narrative ambitions of the texts fail. In the interest of pursuing strategies that would allow me to connect meaningfully with vital materialist concerns and avoid getting bogged down by the strictly formal,
me simultaneously to do justice to the strategies pursued in the works, open them to vital materialisms, and connect them to more contemporary ecological concerns, I have devised my own focal points for the close readings that follow. What this amounts to is a schemata that structures to what, in particular, a reading of these works concerned with affective wonder and how it connects with the ecological and, to a lesser extent, the scientific, should attend. There are thus six categories that have guided my reading — the first four relating explicitly to manifestations and references to wonder and the latter two providing useful connecting points to enchanted science and the ecological.

Before proceeding, the categories are worth outlining here:

1. The first, and I would imagine least, controversial category involves either the implicit or explicit mention of wonder or its analogs (awe, marvel, (re)enchantment). Attending explicitly to wonder is simple enough, in that one simply awaits a keyword like wonder or a variation of it, but “detecting” implicit wonder quickly becomes more complicated. An episode relating the poet-in-scientist’s own experience serves well here, but just as often implicit wonder crops up in the inability to successfully relate an experience (as we will see in Chapter 3 with Wilson’s experience in the Surinamese jungle). More fragmentary references to novel sensations and affiliations, even if posed as hypotheticals, also fall into this category. One may think of Sagan’s mention of “a tingling in the spine, a catch in the voice”\(^\text{115}\) associated with the contemplation of the cosmos. This first category, then, contains both attempts to both articulate and discuss affective wonder reasonably directly.

2. The second category involves references to the infinite, intricacy, and complexity. It includes, in most cases, the poet-in-scientist’s attempt to articulate their engagement with the

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field, a swarm of potential affects — in short, the virtual. This is the realm of Umwelten that one could, in theory, encounter. Here, often, the language of the author’s becomes unusually figurative: Wilson’s “light-points,” which he uses to imagine the unthinkably complex arrangements of life in the rain forest, will provide a good case in point in the next chapter.

3. The flip side of these references to the virtual consists of references to what one might refer to as the actual — in this case to the singularity and precarity of life. While at times this takes the form of descriptions of individual creatures and their Umwelten, such as Wilson’s descriptions of the leafcutter ant, it is just as often about singularity and precarity in the abstract. Lovelock, for instance, likens life on earth to a sandcastle that has miraculously assembled itself on an empty beach.116 Something I refer to as the “affective statistic” also belongs to this category, and crops up often in texts by all three authors: these are back-of-the-envelope calculations (relying on orders of magnitude) geared, most often, at emphasizing the unlikelihood of life developing, or encountering life, in the vast universe. The statistics are affective not because they themselves emphasize affect, but because, if effective, they occasion in the reader an immediate sense of the novelty and improbability in which, merely by living, he or she necessarily participates. As we will see, the affective statistic already overlaps with the territory marked out by the fourth category.

4. The final guiding category dealing with wonder and enchantment itself has been labeled “fits of wonder,” and deals with attempts to expand the readerly Umwelt. One example of this, certainly, is the affective statistic, but it also involves addressing the reader directly, particularly with the use of the first-person plural (we/us/our) and second-person (you/your). Sagan tells us, “Every cell of your body is a kind of commune […]. We are, each of us, a multitude.”117 These “fits

117 Sagan, Cosmos, 21, emphasis added.
of wonder,” in many cases, are also marked by the attempt to bridge the world of the reader and that being discussed by the poet-in-scientist, and thus involve explorations and manipulations of scale. As if operating magical instruments, space and time, here, are expanded and contracted, to suit the poet-in-scientist’s purpose. Ants become as large as people in *Biophilia*, the development of the universe can be mapped onto one calendar year on earth in *Cosmos*, and, in order to explain the complex mechanisms that regulate the chemical content and temperature of our biosphere in *Gaia*, the earth becomes a human body.

5. The fifth category attended to in my readings involves discussions of science. In works of popular science, this may seem hopelessly broad, but, in effect, this pertains to meta-scientific commentary. This is about what science can accomplish, what science as a vocation entails, and what, in the end, looking at the world scientifically means. In a number of places within the texts I focus on, the disenchantment associated with modern science is addressed directly. In a work claiming that these texts are answers to the disenchantment narrative, these discussions are crucial.

6. Finally, I have paid special attention to discussions of ecological ethics and subjectivity, as well as conservation practice. While Sagan deals with the topic slightly more gingerly and broadly, both Lovelock and Wilson make very concrete recommendations for what they believe can and should be done to protect life on earth. I have made a point, in each of the chapters, to try and connect their brands of vital materialism to what they recommend as ecological praxis. In many cases, as we will see, however, the sophistication with which they discuss subjectivity does not translate very well to real-world praxis. It has become necessary, in many cases, to present scenarios that problematize the perhaps hasty recommendations made by the writers, while, at the same time, exploring what, in their more abstract discussions of subjectivity, they may have left untapped.
In practice, of course, these categories, particularly the first four, are not entirely discrete. They have, however, served to structure my readings in a way that has allowed me to articulate the affective ecologies offered by each work, as well as to draw comparisons between them. The last two categories have also served to open up what might ordinarily come off as a hermetic, purely analytic exercise to the overarching questions posed by this work: what kind of reenchanted science is offered by these works? What, potentially, do they have to contribute to thinking ecological ethics and politics? And what kinds of people are being summoned with the “we” that permeates all of these texts? Thus, while on one level, these categories have allowed me to select, to pick and choose what is relevant in the texts and subtract the rest, the last two, in particular, have allowed me, in line with a reparative reading, to vastly multiply the possibilities offered by these works.

And what they offer, although they are responses to the disenchantment narratives most famously articulated by Weber and continuing even today, goes far beyond a mere counter-disenchantment narrative. These authors, at least at their most persuasive, have eschewed narrative altogether. What they confront us with, instead, are tinglings of the spine, catches of the voice, and very, very large numbers. They describe *Umwelten*, worlds, universes teeming with affect and potential, and offer a vision of the human as up to the task of exploring all of these. That these are scientists, and not artists or (at least primarily) environmentalists, that do this is important: time after time, these authors confront us with a science that refuses to separate itself from its object of inquiry. There are no laboratories to be found in these texts, no empty field on which the scientist does his work, but logs crawling with ants, atmospheres populated with innumerable gasses, and a “spaceship of the imagination.” What they give us is an enchanted science because it is an immanent science, of the world. As we will see, their ecological orientation comes from the fact that they have abandoned the notion that science ought to be geared toward mastery. On the contrary, science within these works becomes a way to sense
and attempt to get beyond one’s “tiny sector of nature.” Affective wonder, here, becomes both the engine and byproduct of an enchanted science. But, despite the fact that all of these works can be said to possess an ecological orientation and to offer an enchanted science in which affective wonder plays the key role, each work here offers its own version of the affectively ecological. The following chapters seek, then, not only to trace the various manifestations of affective wonder in the three works but also to articulate the specificity of each of the affective ecologies to which they amount.